DOCUMENT RESUME

ED 146 772 EC 103 355

TITLE	Science: Curriculum Guide for Teaching Gifted Children Science in Grades One Through Three: A Sample Ecology Unit.
INSTITUTION	California State Dept. of Education, Sacramento. Office of Curriculum Services.
SPONS AGENCY	Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.
PUB DATE	77
NOTE	40p.
AVAILABLE FROM	Publication Sales, California State Department of Education, P.O. Box 271, Sacramento, California 95802 ($0.65)
EDRS PRICE	MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; Curriculum Guides; Ecology; Elementary Education; *Gifted; *Lesson Plans; *Natural Sciences; Primary Education; *Science Activities; *Science Curriculum; Sciences; Science Units

ABSTRACT

The natural science curriculum guide for gifted primary students includes a sample teaching-learning plan for an ecology unit and eight sample lesson plans. Chapter One provides an overview of the unit, a review of behavioral objectives, and a list of concepts and generalizations. The second chapter cites a teaching-learning plan dealing with such aspects of ecology as animal movement, seed dispersal, and erosion. Sample lesson plans in the final chapter contain information on behavioral objectives, teaching strategies, suggested activities, and resource materials. (CL)

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CURRICULUM GUIDE FOR TEACHING GIFTED CHILDREN SCIENCE IN GRADES ONE THROUGH THREE

A Sample Ecology Unit

EC 103 355

CALIFORNIA STATE DEPARTMENT OF EDUCATION
Wilson Riles – Superintendent of Public Instruction • Sacramento, 1977

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science

CURRICULUM GUIDE FOR TEACHING GIFTED CHILDREN SCIENCE IN GRADES ONE THROUGH THREE

A Sample Ecology Unit

Prepared for the
OFFICE OF SPECIAL EDUCATION
California State Department of Education

EC103355

This publication, which was funded under provisions of Public Law 93-380, Section 404, was edited and prepared for photo-offset production by the Bureau of Publications, California State Department of Education, and published by the Department, 721 Capitol Mall, Sacramento, CA 95814. The original version, which was published in 1970, was funded under provisions of the Elementary and Secondary Education Act, Title V. The activity which is the subject of this publication was supported in whole or in part by the U.S. Office of Education, Department of Health, Education, and Welfare. However, the opinions expressed herein do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

Printed by the Office of State Printing and distributed under the provisions of the Library Distribution Act

1977

Copies of this publication are available for 65 cents each, plus 6 percent sales tax for California residents, from Publications Sales, California State Department of Education, P.O. Box 271, Sacramento, CA 95802. Information about Department publications referenced in this document and a complete list of publications in the gifted education series may be found on page vi.

A list of other publications that are available from the Department may be obtained by writing to the address given above.

FOREWORD

A primary goal of California public schools is to provide equal opportunity for *all* pupils to become proficient in the basic skills and knowledgeable in the basic subjects. In our efforts to achieve this goal, we must provide programs that are of sufficient scope and depth to permit each child to learn at his or her own rate and to the full level of his or her ability.

Gifted pupils, as a group, have unique educational needs, many of which we can meet only by providing for a high degree of flexibility in their educational programs. Several years ago the Department of Education directed and coordinated a federally funded project for the development of curriculum materials of the type needed for such programs. The 1970 edition of this curriculum guide was a product of those efforts. I am pleased that the Department now has the opportunity to help further the educational opportunities for the gifted by publishing this 1977 edition, *Curriculum Guide for Teaching Gifted Children Science in Grades One Through Three: A Sample Ecology Unit.* I am confident that this updated publication will prove to be as valuable as its predecessor in our efforts to help gifted children realize their full potential.

Superintendent of Public Instruction

PREFACE

This curriculum guide, which was planned and completed originally in 1970 as part of a project under provisions of the Elementary and Secondary Education Act Title V, was updated this year as part of a Public Law 93-380, Section 404, project, Development of Teaching Competencies-Gifted and Talented Education. The guide is intended for use by the teachers of students whose general mental ability places them in the top 2 percent of all boys and girls.

Curriculum Guide for Teaching Gifted Children Science in Grades One Through Three: A Sample Ecology Unit is one of a series of curriculum guides for use by teachers of mentally gifted students. The 1970 edition of the guide was written by Charlotte Morrison, Teacher, Educationally Handicapped and Learning Disabled, Burbank Unified School District. She prepared the guide under the direction of John C. Gowan, Professor of Education, and his assistant, Joyce Sonntag, Assistant Professor of Education, both of San Fernando Valley State College (now California State University, Northridge). The guide was updated by Howard N. Hubbard, Long Beach Unified School District, under the direction of Paul D. Plowman, Consultant, Gifted and Talented Education, California State Department of Education; and Director, Development of Teaching Competencies–Gifted and Talented Education Project.

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Publications Available from the California State Department of Education

The following publications, which are referenced in this curriculum guide, are available from the California State Department of Education, at a price of 65 cents per copy, plus sales tax for California residents:

Ekistics (1973)
Science Framework for California Public Schools: Kindergarten–Grades One Through Twelve (1970)

The following publications in the gifted education series are also available from the Department, each at a price of 65 cents per copy, plus sales tax for California residents:

Curriculum Guide for Teaching Gifted Children Literature in Grades One Through Three (1977)*
Curriculum Guide for Teaching Gifted Children Science in Grades One Through Three (1977)*
Curriculum Guide for Teaching Gifted Children Science in Grades Four Through Six (1977)*
Curriculum Guide for Teaching Gifted Children Social Sciences in Grades One Through Three (1977)*
Curriculum Guide for Teaching Gifted Children Social Sciences in Grades Four Through Six (1977)*
Special Programs for Gifted Pupils (1962)
Teaching Gifted Children Art in Grades Four Through Six (1973)
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Teaching Gifted Students Art in Grades Ten Through Twelve (1973)
Teaching Gifted Children Music in Grades One Through Six (1977)
Teaching Gifted Students Foreign Language in Grades Ten Through Twelve (1973)
Teaching Gifted Students Social Sciences in Grades Seven Through Nine (1977)**

Payment should accompany order. Purchase orders without checks are accepted from governmental agencies in California.

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*Revision of publication originally issued in 1970.
**Revision of publication originally issued in 1972.

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CHAPTER 1

Purposes and Approaches

It is the intent of this guide to help gifted pupils in grades one, two, and three to take an active part in meaningful learning activities that concern the world of natural science. The guide includes a sample teaching-learning plan for a unit and eight sample lesson plans. The emphasis of the unit is on ecology and on various aspects of that branch of science, such as the biological, the environmental, and the geological.

Overview

Chapter 1 includes a general view of the unit, a set of behavioral objectives, and a list of generalizations and concepts. Chapter 2 offers a sample teaching-learning plan for the complete unit. Chapter 3, dealing with the subject matter of the unit, contains eight sample lesson plans; each lesson deals with a different ecological topic.

Each of the eight lessons in Chapter 3 begins with an appraisal of the knowledge the pupil may already possess. The children are then asked to organize their knowledge into useful patterns so that they may be able to apply it to gain new insights. Experiments and investigations are to be done individually or in small groups and are to be followed by sharing of observations with the entire class.

Much of the work is to be carried on through group discussion, for it is during the use of this technique that the pupils put their ideas into words. The willingness of the teacher to accept unusual ideas while requiring some justification for the ideas is the key to setting the classroom climate and is a highly effective means of motivating the pupils to commit themselves with enthusiasm to this work.

Creative writing activities may have a very personal meaning for some of the pupils; their efforts should be kept private if they do not wish to share them. Grade marks for achievement should not be given for these activities, and the children should be aware that no marks will be recorded. The purpose of the creative writing activities

is to give pupils an opportunity to express their feelings about nature.

Behavioral Objectives

In the preparation of this guide, ample attention has been given to the research of Jerome S. Bruner, of J. P. Guilford and P. R. Merrifield (University of Southern California), and of Benjamin S. Bloom and his associates. Special attention has been directed to the affective and cognitive domains of learning, as explored in *Taxonomy of Educational Objectives*.[1] Certain functions in those domains are designated in the list of objectives that follows:

- The pupils will express a desire to know why organisms behave as they do in the organisms' environments. (Knowledge, response)
- The pupils will identify specific information needed to answer their questions. (Comprehension, response)
- The pupils will seek means to answer their questions through experiments, resource materials, and resource personnel. (Comprehension, analysis, receiving, responding)
- The pupils will share information, as well as identify needs when information is lacking, by means of class discussions. (Analyzing, responding, valuing)
- The pupils will classify information on the basis of appropriate categories. (Comprehension, response)
- The pupils will find relationships between environmental conditions and the ways in which organisms respond. (Synthesis, organization)
- The pupils will express feelings of responsibility for the roles people play in ecological balance. (Evaluation, characterization)
- The pupils will recognize and express an appreciation for the aesthetic qualities of nature through interpretive behavior. (Application, synthesis, responding, valuing)

Other organizations of goals and objectives are equally appropriate. *Science Framework for California Public Schools: Kindergarten–Grades One Through Twelve* includes a number of objectives under goals dealing with attitudes, thinking processes, skills, and

[1] *Taxonomy of Educational Objectives: The Classification of Educational Goals.* In two volumes. *Handbook I: Cognitive Domain.* Edited by Benjamin S. Bloom and others, 1956. *Handbook II: Affective Domain.* Edited by D. R. Krathwohl and others, 1964. New York: David McKay Co., Inc.

knowledge.[2] Objectives in *McGraw-Hill Evaluation Program for ESS* are grouped under the following headings: rational thinking process, manipulation, communication, concepts, and attitudes.[3]

Generalizations and Concepts

After the children have completed the unit, it is expected that they will understand and appreciate, at their particular level of sophistication, the following generalizations and concepts:

- The substratum is the base on which an organism lives. As used in this guide, the term *substratum* is roughly equivalent to the more commonly used term *ecosystem.*
- Organisms have certain physical characteristics that enable them to live on or in their substrata.
- Animal movement falls into types of movement that are made possible by certain physical characteristics which the animals possess.
- Survival of the species is related to animal movement, as in the instances of migration, self-protection, and the seeking of food.
- There is beauty in the movement of animals.
- Seed dispersal is identified on the basis of types of dispersal that are made possible by certain characteristics of the seeds.
- Improved chances of germination are related to the type of seed dispersal within a given environment.
- Scientists of the past have used techniques which can be duplicated by elementary students.
- There is a large number of dormant seeds in the soil.
- Life would not exist in the way that we know it if the heat from the sun were lost.
- People adjust temperature extremes to suit themselves through temperature-control devices.

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[2] *Science Framework for California Public Schools: Kindergarten–Grades One Through Twelve.* Sacramento: California State Department of Education, 1970.

[3] *McGraw-Hill Evaluation Program for ESS.* New York: McGraw-Hill Book Company, Webster Division, 1974.

CHAPTER 2

Sample Teaching-Learning Plan

The following sample shows the type of teaching-learning plan that can be drawn up for a science unit for gifted pupils in grades one through three.

A Unit on Ecology

Ecology is the study of the relationships between organisms (living things) and their environments. Such relationships include the interactions of organisms with other organisms and with nonliving objects in their surroundings. This unit consists of eight lessons, each of which pertains to an important aspect of ecological science: substratum, animal movement, seed dispersal, temperature, light, food, water, and erosion. Suggested activities and assignments for the pupils are listed under each sidehead below.

Substratum

1. Identify various substrata.
2. Recognize characteristics of substrata.
3. Observe organisms' physical adaptations to substrata.

Animal Movement

1. Identify and classify types of movement.
2. Determine the relationship between the movement and the substratum.
3. Relate the movement to the survival of the species.
4. Appreciate the aesthetic qualities of movement.

Seed Dispersal

1. Identify and classify categories of seed dispersal.
2. Relate dispersal to the survival of the species.
3. Learn of earlier research techniques.

Temperature

1. Recognize the necessity of receiving heat from the sun for life on earth.
2. Identify ways in which organisms adapt to temperature changes.

Light

1. Investigate responses of organisms to light.
2. Experience human adaptive powers in response to lack of light.

Food

1. Establish a relationship between organisms and their sources of food.
2. Observe physical characteristics of organisms that enable them to obtain food.
3. Become aware of some causes of famine and ways in which food supplies can be restored.

Water

1. Experiment to understand (a) movement of water through a growing plant; (b) transpiration; and (c) water-seeking roots.
2. Learn of physical adaptations—on the part of some animals—that compensate for a lack of water in their environment.
3. Become aware of people's efforts to provide themselves with an adequate water supply.

Erosion

1. Experiment to observe causes of erosion.
2. Relate erosion to ecological balance.
3. Consider the role of people in erosion control.

Many good reference materials are available for use by teachers of children in grades one, two, and three. The California State Department of Education publication entitled *Ekistics* is recommended as the primary reference work for teachers.[1] The suggested learning experiences included in this document are excellent. Teachers should also find very helpful the chapter entitled "War and Peace Among the Niches" in Mary Budd Rowe's *Teaching Science as Continuous Inquiry*.[2]

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[1] *Ekistics*. Sacramento: California State Department of Education, 1973.

[2] Rowe, Mary Budd. *Teaching Science as Continuous Inquiry*. New York: McGraw-Hill Book Company, 1973.

A number of periodicals generally contain ecology-oriented material that would be of interest to teachers and/or students. Almost every issue of *Science and Children*, published by the National Science Teachers Association, includes material on ecology. *National Wildlife*, published by the National Wildlife Federation, is appropriate for use by teachers; and *Ranger Rick*, another publication of the National Wildlife Federation, can be used by children.

Other recommended materials are the Science Curriculum Improvement Study Units "Populations" and "Environments," produced by Rand McNally and Company; and selected kits from McGraw-Hill's *Elementary Science Study* series. Among those recommended most strongly from the latter are *Growing Seeds*, *Brine Shrimp*, *Pond Water*, and *Crayfish*.

Evaluation

As the children proceed through the unit, it would be well, of course, for the teacher to evaluate as often as possible the progress they are making. Techniques employed, materials used, degree of enthusiasm shown, and any problems that might be manifested should be appraised.

Moreover, the pupils should be encouraged to make their own evaluations and be given whatever guidance they need in this effort. The pupils need to (1) understand why self-evaluation is important to learning; and (2) develop gradually and securely the habit of making meaningful evaluations by themselves.

Evaluation strategies are generally part of commercially produced, complete programs.

Teachers are encouraged to read the chapter on evaluation in *Teaching Science as Continuous Inquiry*.

CHAPTER 3

Sample Lesson Plans

The eight proposed lesson plans on the study of ecology are presented in this chapter. Each lesson includes behavioral objectives, recommended teaching strategies, suggested pupil activities and experiences, and lists of resource materials.

Lesson One: Substratum

Lesson one is intended for use with a cluster group or with an entire class. Much of the work is based on verbalization of ideas. The teacher should recognize that verbalization of self-generated ideas may take a great deal of courage on the part of some of the children. Willingness of the pupils to share knowledge and to admit lack of knowledge can be nurtured through a respectful attitude on the part of the teacher. In this way the teacher will be acting as a model upon which the children can base their own behavior.

Behavioral Objectives

Affective:

The pupils will receive and respond to the ideas of the class. (Receiving, responding)

The pupils will share new knowledge with the rest of the group or class. (Responding, valuing)

Cognitive:

The pupils will frame questions with the clarity and specificity necessary to acquire information. (Analysis, response)

The pupils will formulate a definition of the term *substratum.* (Synthesis)

The pupils will be able to identify numerous examples of substrata and some organisms that live on them. (Knowledge)

The pupils will use resource materials to find answers to questions left unanswered by their observations. (Response, analysis, application)

The pupils will communicate to the group or class their understanding of the relationship between a substratum and the physical characteristic of the organisms living on the substratum. (Comprehension, application, response)

Teaching Strategies

The teacher provides a challenging way of arriving at the meaning of substratum by showing a film, identifying the substratum, and then having the children define the term.

The teacher asks the pupils to suggest additional examples of substrata to demonstrate their understanding of this term.

The teacher allows time for the boys and girls to receive and respond to ideas of individual learners.

The teacher encourages pupil-directed learning by providing an opportunity for observation and investigation of the physical characteristics of an available organism. Possibilities include earthworms, snails, and sow bugs.

The teacher stimulates further reading by anticipating needs and making suitable references easily accessible.

Suggested Activities

Show a film that illustrates the concept of the term *substratum*. *Life on a Dead Tree* and *Life in a Vacant Lot* are two films that would be excellent for this purpose. Identify the organisms that live on a given substratum, and develop a working definition of the term.

Evaluate the pupils' understanding of the term by asking them to name other substrata (e.g., a freshwater stream or a stagnant pond).

Have the boys and girls make a bingo-like game by writing the names of nine different substrata in nine squares on 23 cm x 23 cm cards. Each card should have the names of the substrata arranged in a different order. From small cards with organisms' names written on the front and the matching substratum written on the back, read to the pupils the names of the organisms that live in the various substrata. The children should cover the appropriate substratum squares on their cards with markers when they hear matching organisms named. Three substrata covered in a straight line make a bingo. A check for correctness of answers can be made by referring to the back sides of the teacher's cards.

Provide to each pupil a hand magnifier and a live organism, such as an earthworm, a snail, or a sow bug. Remind the pupils that no living organism should be mistreated and that the behavior of the organism can be easily observed without excessively poking and pushing it.

After the pupils have studied their organism, ask them to describe its movement. Insofar as possible respond to their questions with a question. For example, "How do you suggest we find out?"

Discuss how the needs of the organism are met (food, breathing, and so forth). Have the pupils share their observations, inferences, and conclusions.

Answers to questions that are still unanswered should be sought by the learners in reference materials made available by the teacher.

Retain the organism in a suitable environment (damp soil, for example) for further study.

The pupils should be instructed to watch for examples of organisms that have different physical characteristics and that use different ways to achieve similar results within the same substratum. An example would be the ways in which an octopus, a fish, and a starfish move about. These three creatures have different physical structures and move in different ways; and yet they all exist within the same substratum.

Instruct the children to look through resource materials and to try to find an interesting example of a physical characteristic that permits an organism to survive in its particular substratum. Then let each pupil present his or her example to the group or class. Encourage a variety of kinds of presentation, such as the use of large illustrations or models, chalk talks, live demonstrations, or oral reports. The following exemplify the kinds of things that can be reported on: birds' feet, which are adapted to holding on to branches; frogs' eyes, which have transparent lids that close under water; and lizards' skins, which preserve the body moisture of lizards.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Hand magnifier (Most science supply houses offer an unbreakable magnifier with several magnifications.)

Motion picture projector

MATERIALS FOR ACTIVITIES

Cards scored like bingo cards (large size, 23 cm x 23 cm)

Cards with names of organisms written on the fronts and kinds of substrata designated on the backs (small cards)

Available organism for study (earthworm, snail, sow bug, or the like)

Large jar containing damp earth

Markers for a bingo-like game

SELECTED REFERENCES

Books, articles, and miscellaneous

Anderson, Margaret J. "The Underwater World of the Caddisfly," *Nature and Science,* V (July 8, 1968), 14-15.

Ballin, Alice. "Woodland Activity Book," *Science and Children,* XII (April, 1976), 16-17.

Earthworms. ELEMENTARY SCIENCE STUDY. New York: McGraw-Hill Book Company, Webster Division, 1971.

Hogner, Dorothy Childs. *Earthworms.* New York: Thomas Y. Crowell Company, 1953.

Kramer, David C. "Isopods: The Un-Bugs," *Science and Children,* XI (January, February, 1974), 14-15.

Ochs, V. Daniel. "Bottle Biology," *Science and Children,* XIII (October, 1975), 15–17.

Ripper, Charles L. *Moles and Shrews.* New York: William Morrow and Co., 1957.

Selsam, Millicent, and Betty Morrow. *See Through the Sea.* New York: Harper & Row Pubs., 1955.

Films:

The Freshwater Pond. Encyclopaedia Britannica Films, Inc., 1962.

Animals That Live in the Surf. Sutherland Educational Films, 1965.

The Freshwater Pond. Encyclopaedia Britannica Films, Inc., 1966.

Introducing Ecology: Dependence and Sharing. Coronet Instructional Media, 1972.

Life in a Vacant Lot. Encyclopaedia Britannica Films, Inc., 1966.

Life in the Ocean. Film Associates of California, 1955.

Life on a Dead Tree. Film Associates of California, 1957.

Wonders in Your Own Backyard. Churchill Film Productions, 1949.

(Other films, filmstrips, and cassette-filmstrip packages may be used as appropriate.)

Lesson Two: Animal Movement

The characteristic movements of plants and animals are basic to a study of ecology. This lesson concentrates on the movements of various kinds of animal life. Young children are naturally curious about animals, large and small, and can, with appropriate instruction and guidance, learn a great deal about animal movement and related behavior. The content suggested here is suitable for use by an entire class.

Behavioral Objectives

Affective:

The pupils will express interest in investigating physical characteristics of insects to determine how they are able to move. (Response)

The pupils will contribute ideas while considering questions about migration. (Response)

The pupils will express appreciation for the aesthetic qualities of animal movement through the use of various art forms. (Valuation)

Cognitive:

The pupils will be able to identify some basic types of insect movement and to classify insects within these categories. (Comprehension, knowledge)

The pupils will be able to recognize some physical characteristics that enable insects to move in the ways they do. (Extrapolation)

The pupils will explain the relationship between animal movement and the substratum. (Comprehension, response)

The pupils will describe the relationship between migration and survival of the species. (Application)

Teaching Strategies

The teacher provides opportunities for observation of physical characteristics of insects and animals with which the children are familiar.

The teacher encourages the pupils to form hypotheses and to become aware of gaps in their information by means of group discussions.

The teacher provides for knowledge exploration by asking provocative questions.

The teacher provides resource materials.

The teacher gives the children opportunities to express some of their ideas in three-dimensional art forms.

The teacher helps the pupils to develop visualization skills and awareness by showing them a way to describe views from an unaccustomed vantage point.

The teacher reinforces originality by providing a receptive atmosphere.

Suggested Activities

Arrange a study trip to a vacant lot, a stream, a pond, a backyard, or a remote part of the school playground. (Parks and public areas are often sprayed for the elimination of insects and would have very little to offer.) Ask the pupils to observe the way insects move and where they go. The observations should be recorded and tabulated during the trip to identify the most frequently used mode of

movement and its purpose. Encourage the children to catch samples of the kinds of insects they discover along the way or at the site chosen. Feet, wings, and other distinguishing appendages or parts should be examined with magnifying instruments. Sketches can be made during the trip or later at school if the pupils desire to do so.

Supervise an insect race. Provide a sheet of paper with a large circle drawn on it. Mark the center of the circle. Have each pupil place an insect of his or her choice (no flying insects) at the center and watch closely to see which insect gets to the outside of the circle first. About five insects may race at a time.

Show a film about a common insect. Be sure that the film shows the characteristic parts of the insect. Then compare the insect shown in the film with those that were noted on the study trip.

Show the film *Animals–Ways They Move* or a similar film.

Arrange a library period during which the learners can examine books and articles having to do with animal movement.

Ask each pupil to think of an animal he or she especially likes and to make a model of it out of clay.

Have each child arrange or construct a simple background to illustrate the substratum on which the animal of his or her choice lives. Encourage each child to point out the physical characteristics that permit his or her animal to be mobile on or in its particular substratum.

Ask what changes of environment take place in Canada and in our northern states in the late fall and early winter. (Temperature and availability of food are the factors to be emphasized.)

Continue questioning in the following manner:

- "How do birds survive with no fruits, seeds, or insects available in the winter?"
- "Why don't all birds just stay in the warmer areas of the country all of the time?"
- "Do salmon and ducks have the same reason for migrating?"
- "What would happen to the salmon if they stopped migrating?"
- "Do people ever migrate?"
- "What environmental changes cause people to migrate?"

Ask the class to watch and study the flight patterns of birds. (Some species of birds have definite flight patterns which can be identified; for example, flap-flap-flap-glide or flap-glide, flap-glide.)

Have the children finger-sketch in the air the flight patterns they observe.

Suggest to the pupils that a bird flight pattern has a certain beauty that can be captured by putting it into an art form. Ask them for any

ideas they might have as to how to do this. (A well-observed pattern can become the basis of a creative dance, such as a step-step-step-slide; the meter for poetry; the line for painting or sketching; or the rhythm for music.)

Encourage the children to use the patterns they have chosen in ways that show the beauty, the symmetry, and the gracefulness of the flights of birds.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Hand magnifier–one per pupil

Motion picture projector

MATERIALS FOR ACTIVITIES

A large sheet of light-colored paper, 61 cm x 92 cm, with a 61-cm-diameter circle and its center point drawn on the paper

Notebooks and pencils

A small drum and other rhythm instruments

A supply of clay

A variety of art materials (paints, starch, yarn, glue, straws, sticks, pipe cleaners, feathers, wire, and the like)

SELECTED REFERENCES

Book and articles:

Berrill, Jacquelyn. *Wonders of Animal Migration.* New York: Dodd, Mead & Company, 1964.

Carr, Archie. "How Do Turtles Find the Sea?" *Nature and Science,* VI (January 6, 1969), 12–14.

Kane, Henry B. *Wings, Legs, or Fins.* New York: Alfred A. Knopf, Inc., 1965.

McClung, Robert. *Mammals and How They Live.* New York: Random House, Inc., 1963. (See especially pp. 20–26.)

Morris, Steven W. "Hitch-Hikers of the Sea," *Nature and Science,* IV (March 13, 1967), 11–13.

Ravielli, Anthony. *From Fins to Hands.* New York: Viking Press, Inc., 1968.

Films:

Animals That Fly. Film Associates of California, 1961.

Animals–Ways They Move. Encyclopaedia Britannica Films, Inc., 1956.

Snails: Backyard Science. Film Associates of California, 1965.

Wonder of Grasshoppers. The Moody Institute of Science, 1959.

Lesson Three: Seed Dispersal

This section can be adapted for use with a cluster group or with individual pupils. The problems presented here have solutions based

on direct observation and provide excellent opportunities for the children to work independently. For the purposes of this lesson, it is recommended that the teacher act as a resource person and offer advice only if it is solicited by the pupil.

The creative writing experiences encouraged in this phase of the unit may have a very direct, personal meaning for some children. What they write, therefore, should be kept confidential if they prefer privacy. These creative activities are planned to give pupils an opportunity to express their own feelings about the world of nature.

Behavioral Objectives

Affective:

The pupils will describe the character or quality of nature as it relates to the whimsical, almost haphazard process that results in the continuation of plant life in nature. (Characterization)

Cognitive:

The pupils will learn to identify four categories of seed dispersal. (Knowing, receiving)

The pupils will classify seeds on the basis of the way they are dispersed. (Comprehension, response)

The pupils will investigate seeds to learn how they disperse. (Analysis)

The pupils will relate types of seed dispersal to improved chances of germination. (Application)

The pupils will become acquainted with the method used by Charles Darwin to find out how many seeds are contained in a given amount of soil. (Knowledge)

The pupils will investigate to determine how great a number of seeds is necessary to ensure continuation of the species. (Organization)

Teaching Strategies

The teacher provides an opportunity for the children to note the similarities between things by having the children identify the inherent properties of the seeds.

The teacher uses a game as a problem-solving approach to the stimulation of the skills of search.

The teacher elicits exploratory responses by providing opportunities for the pupils to examine phenomena through experiments.

The teacher guides the pupils through a study of the work of creative people, considering the methods that these persons devised and used.

Suggested Activities

By the time they reach the third grade, many children will have a general understanding of how seeds disperse. In a group discussion the teacher can test to determine whether the pupils are familiar with such categories of dispersal as airborne, clinging, popping or dropping, waterborne, and seeding through animal droppings. If the students are familiar with these categories, the teacher may move on to the seed-box race activity. If categories of dispersal are not clearly understood, the teacher may proceed as follows:

- Enlarged, teacher-made sketches of three or four seeds representing two categories of seed dispersal may be shown on an overhead projector.
- The pupils should experiment with real seeds to determine the type of movement of each seed and to identify the characteristics that permit or enhance this movement.
- The pupils should locate on each projected sketch the sets of seeds that belong in the same categories.

Seed-box race:

Each pupil should have a shoe box with enough seeds in it to cover the bottom. The seeds should represent several categories of dispersal.

At a signal from the teacher, the children should begin to separate the seeds into piles representing categories of dispersal. The boys and girls should quickly recognize that they need to devise ways to separate the seeds in groups rather than to separate them one by one. (They might draw a strip of cloth through the box to collect the seeds that cling, fan the box to blow out the airborne seeds, and so forth.)

Winning the race—getting all the seeds in the box classified—should not be emphasized, but the methods used to separate the seeds should be discussed.

Further investigation of seed categories:

Clinging seeds should be examined with a magnifying glass or a microscope; the shapes of the hooks and barbs should be compared.

The pupils should make enlarged sketches of the hooks and barbs.

The learners may use the various shapes of these hooks and barbs as individual pieces for a mosaic art project. Each piece of the mosaic should be made in the shape of a hook or barb observed on a seed. The overall design of the mosaic is not to be prescribed.

Airborne seeds should be observed in motion to see whether their motion is consistent or haphazard.

The children should be encouraged to try to find out why some seeds spin or float through the air in a consistent manner. Pupil-created experiments, such as dropping seeds onto a bed of loose sand, will demonstrate how the seeds can penetrate the surface of the soil to improve chances of germination.

Popping or dropping seeds can be observed by hanging ripe but still-closed pinecones or eucalyptus pods in a warm, dry place in the classroom. Light-colored paper should be placed under them. Care must be taken to hang these seed pods in the direction they take when they hang naturally on the trees. In time, the seeds will drop onto the paper.

The concept that humidity is a factor in seed dispersal can be demonstrated by placing an open pinecone and a dandelion with a full head of seeds in a shallow pan with a small amount of water in it, covering the pan with clear plastic, and setting the pan in the sun. The air under the plastic will become more moist. The pupils will observe the pinecone and the dandelion gradually closing. The class should be made aware of the relationship of this phenomenon to the probability of successful germination of the seeds.

The film *Seed Dispersal* can then be shown, with the sound turned off.

The teacher should ask the children to recall examples of seed dispersal seen in the film. A list should be made. The children should also identify the categories of dispersal represented.

Next, the teacher can read of an investigation made by Charles Darwin to determine how many seeds were found in a given amount of soil. (See Millicent Selsam's book *Play with Seeds.*) The pupils should duplicate the experiment.

The film *Leaf* can be shown at this point. In this special feature music is substituted for narration. The music follows the path of an autumn leaf as it soars on the wind in a Yosemite canyon and floats down a stream.

Each learner should write down what he or she thinks his or her own feelings might be if tossed by the wind and carried gently along by the water, much as a leaf or a seed. The class should be allowed to use either prose or poetry in writing these impressions.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Hand magnifier – one per pupil
Microscopes
Motion picture projector

MATERIALS FOR ACTIVITIES

Colored construction paper, scissors, paste for mosaics

A dandelion with a full head of seeds

Enlarged teacher-made transparencies (for the overhead projector), showing three or four seeds and representing two categories of seed dispersal

Eucalyptus seed pods

One inch of sand in a shallow box

An open pinecone

Ripe but closed pinecones

Shoe boxes (or boxes of similar type)—one per pupil

A variety of seeds, in quantities sufficient to cover the bottoms of all the shoe boxes

Writing materials

SELECTED REFERENCES

Books and articles:

Falk, John H. "Wheeling Your Way Through the Outdoors," *Science and Children,* XI (May, 1974), 10-11.

Hammond, Winifred G. *The Riddle of the Seeds.* New York: Coward-McCann, Inc., 1966.

Jordan, Helene J. *Seeds by Wind and Water.* New York: Thomas Y. Crowell Company, 1962.

Selsam, Millicent E. *Play with Seeds.* New York: William Morrow and Co., 1957. (See especially p. 48.)

Films:

How Seeds Are Scattered. International Film Bureau, 1973.

Leaf. Pyramid Film Productions, 1962.

Seed Dispersal (Second edition). Encyclopaedia Britannica Films, Inc., 1957.

Lesson Four:
Temperature—Its Influence on the Environment

To try to assign a particular time allotment for the questioning in this section would be unwise. The pupils might answer the first question so completely that some other questions would be redundant; or there might be a need to spend extra time on particular aspects of the lesson. The teaching-learning situation must be flexible.

This lesson provides excellent opportunities for the children to acquire practice in critical thinking and in the precise communication of their own ideas. As it was pointed out in Chapter 1, the willingness of the teacher to accept unusual ideas while requiring some foundation for them is vital to the classroom climate and is indispensable to pupil motivation.

Behavioral Objectives

Affective:

The pupils will give evidence of their enjoyment in becoming involved in activities and experiments to support their hypotheses. (Valuation)

The pupils will show interest in watching for evidences of hibernation taking place in a frog. (Comprehension, response)

Cognitive:

The pupils will form hypotheses about the consequences of a loss of heat from the sun to the earth. (Analysis, response)

The pupils will identify four ways in which life adapts itself to extremes of temperature. (Knowledge)

The pupils will compare the ability of human beings with that of other animals to adapt to extremes of temperature. (A ıalysis)

Teaching Strategies

The teacher elicits exploratory responses by proposing questions.

The teacher encourages the pupils to find answers to their own questions through experimentation.

The teacher improves the learner's skills in idea generation by motivating him or her to read and listen discriminately and by providing him or her with suitable materials for research.

The teacher arranges activities that will help the children to interact intelligently with their peers. For example, group discussions of some of the more difficult questions can be held; by taking part in these discussions, the children can develop skills in receiving and responding to the ideas of other persons.

The teacher encourages the development of the pupil's skill in expressing his or her emotions effectively and constructively by creating a receptive classroom atmosphere. The child feels he or she is appreciated and respected; therefore, he or she *wants* to learn and to express himself or herself.

Suggested Questions and Activities

"What would happen if the sun cooled down so much that the earth got very cold? Would life cease to exist?" If the pupils believe that life would cease to exist, remind them that humans are intelligent beings and are able to explore the polar regions.

The teacher may then need to ask: "How do people survive in so greatly changed an environment?" In contributing and hearing answers to this question, the children would come to recognize that people are able to explore the polar regions only because they bring with them, from warmer areas, the things that are necessary for survival.

"How would reduction of heat from the sun affect such bodies of water as rivers, lakes, and oceans?" The learners may have some questions about ice forming on moving water and on still water, or about ice forming in bodies of salt water or fresh water. This querying can be expanded into an experiment whereby the children freeze tap water and salt water to find out whether there is a difference between their freezing rates. It is important that the pupils set up most of this experiment by themselves, with guidance from the teacher only when needed. They should determine what equipment they require and what procedure they will use, and they should keep records of what happens. After they discover that salt inhibits freezing, they should be encouraged to think of ways in which this information could be used to man's advantage.

"Do you think that the oceans would freeze solid to the ocean floors?"

"If ponds and lakes freeze to the bottom, how do the fish survive?"

"In the polar regions are the icebergs frozen to the floor of the ocean?"

"Can you think of any benefits that might be derived as a result of a cold earth?" Any of the benefits of refrigeration would be appropriate. Inquiry should be made as to how the products to be refrigerated would be obtained.

"Is the sun the only source of heat for the planet Earth?" If the pupils bring up ways to produce heat for buildings and the like, it would be advantageous for the class to investigate the source of energy for the fuel in question; for example, coal and oil come from plant and animal life, which got their energy from the sun.

"How would the presence of a volcano affect a small area of a cold earth?" Warm air rising from a volcano would create some winds that could be investigated. Warm air rising can be observed in the classroom by using a light bulb to heat the air and suspending tissue paper to make the motion of the air visible.

"Would this result in rain?" The learners should be encouraged to find answers to this and other questions by means of reference materials. It is the teacher's place, at this age level, to make sure that references are found by the children without undue delay and that in each instance the child participates in locating the references.

"Where is the earth hot enough to melt rock?" The existence of heat within the earth, as distinguished from outside heat that comes from the sun, is the concept to be brought out here.

"Two sources of heat for the earth have been identified. How can you tell which source provides the heat necessary to cause seeds to sprout?" A household thermometer can be placed in the ground at

various depths to measure temperature differences. The ground should be opened with a trowel and closed quickly so that a temperature change will not be caused by the surface air. The pupils should note that at the surface of the ground the soil temperature is several degrees hotter than it is a few inches below the surface.

"What do people do to make themselves more comfortable when the weather is too cold or too hot?" The responses of the children should be recorded in three appropriate columns, without headings. The columns should correspond to certain categories, such as "adapts clothing," "adapts environment" (housing, automobiles, and the like), and "adapts food and beverage." The pupils can then identify the characteristics that are in common with each column and can give titles to the columns.

"People are just one variety of animal. How do other animals solve the problem of adapting to temperature extremes?" The learners should now consider, first through research and then through small-group discussion, the ways in which animals adapt themselves to extremes of temperature. Each group needs a pupil representative who can either write or put on a tape recorder the ideas brought out in the discussion. The learners should be looking for the broad classifications of adaptive abilities of animals, such as hibernation and estivation, rather than examples of individual animal adaptation to temperature extremes.

It would be appropriate at this time to show the films *The Desert Community* and *Hibernation and Other Forms of Dormancy*. The children should be allowed to add to their lists of broad classifications of adaptive abilities of animals.

"What differences are there between the adaptive ability of people and that of other animals?"

Resource Materials

EQUIPMENT FOR ACTIVITIES

Household thermometers, one per five pupils

Motion picture projector

Tape recorders—one per five pupils

MATERIALS FOR ACTIVITIES

A supply of ice for classroom experiments

Transparent containers, all of the same size and shape

SELECTED REFERENCES

Books and articles:

Fenton, Carroll L., and Mildred A. Fenton. *Our Changing Weather*. Garden City, N.Y.: Doubleday & Company, Inc., 1954.

Hankla, Alice K. "An Energy Conference for Little People," *Science and Children*, XII (April, 1975), 21–23.

Kirk, Ruth. "Survival in the Desert," *Nature and Science*, V (October 30, 1967), 4.

Sutton, Ann, and Myron Sutton. *The Life of the Desert*. New York: McGraw-Hill Book Company, 1966.

Webster, David. "Exploring Winter Ice," *Nature and Science*, VI (January 3, 1969), 4.

Wyler, Rose. *The First Book of Weather*. New York: Franklin Watts, Inc., 1956.

Films:

Animals of Alaska. Northern Films, 1958.

The Desert Community. Encyclopaedia Britannica Films, Inc., 1965.

Hibernation and Other Forms of Dormancy. Encyclopaedia Britannica Films, Inc., 1962.

Life on the Tundra. Encyclopaedia Britannica Films, Inc., 1965.

Living Mammals. International Film Bureau, 1960.

Lesson Five: Light

Although parts of this section can be done by an individual student, in general it is more suitable for use by a cluster group or by an entire class.

Behavioral Objectives

Cognitive:

The pupils will develop hypotheses about the effects of certain variables of light upon the growth of plants. (Application, valuation)

The pupils will carry out experiments to test their hypotheses. (Response, analysis)

The pupils will observe in other organisms certain responses that are the result of light sensitivity. (Knowing, receiving)

The pupils will participate in experiences in which their other senses must compensate for the simulated loss of the use of sight. (Analysis, characterization)

Teaching Strategies

The teacher provides time and materials for the pupils to plan and carry out experiments to test their hypotheses.

The teacher helps the children to improve their skills of search by elaborating upon structures with which they are already familiar.

The teacher encourages the learners to be on the alert for information that allows one factor to lead to another factor as they listen to readings about phenomena related to light sensitivity not observable in the classroom.

Suggested Activities

Review, through class discussion, previous pupil observations of plants seeking light.

Ask what differences the children think there might be in the growth of a plant if the light on the plant were colored. Discuss ways in which the pupils could find out. (They should consider doing experiments, carrying out research in books and periodicals, asking resource persons, and so on.)

Ask the children whether they believe that the intensity of light might have an effect on seed germination. (Encourage them to give reasons to support their hypotheses.)

Determine whether the pupils can think of other variables of light, such as the amount of light measured by time or the properties of sunlight compared with those of artificial light.

Allow the learners, individually or in small groups, to choose a variable of light to test by means of an experiment. Each pupil should form a hypothesis about the probable effect his or her test will have on a plant, write the hypothesis on a piece of paper, and seal the paper in an envelope to be kept in his or her own desk.

The experiment should then be planned and carried out.

When individuals or members of a group agree that their experiments are completed, they should make written summaries to be shared with the rest of the class.

Each pupil should open his or her own envelope to see how right or wrong his or her hypothesis is. (This action is a private one, and the results do not need to be shared with the class unless the child volunteers.) If any experiments have failed completely, the teacher may bring all the pupils together to consider the problems encountered.

Next, provide each child with an earthworm and a magnifying glass. Tell the children to look for eyes. (There are none.)

Have each pupil construct, from a scrap of paper, a small arch that will cast a shadow on one end of his or her earthworm. Direct him or her to shine a light on the other end to see if the worm will repeatedly move away from the light. Ask the pupils why earthworms would have any need to be sensitive to light.

Encourage the learners to predict whether snails, ants, sow bugs, ladybugs, and other small creatures would likely be sensitive to light. (They should note that organisms are able to adapt themselves to living in certain environments.)

Now, blindfold several pupils. Tell them that they will need to use other senses to substitute for the light that enables them to have sight.

During this experience of temporary "blindness," the children should have no trouble identifying certain sounds without being able to see what is happening; for example, the scraping of chalk as someone uses it on the chalkboard or the squeak and the smell of a felt marker as someone writes with it on a chart.

One group of children can devise ways of employing two senses at a time while other groups try to guess, without being able to see. They might try to identify the following: the sound and the feel of moving air as pages of a book are allowed to turn under one's thumb, the sound of pouring a carbonated drink and the feel of its gas bubbles, the impact and the sound of a large book having been dropped on the floor, the taste and the smell of a piece of chocolate candy, and so forth.

Having had several experiences of being able to sense without seeing, the learners will have a better understanding of the adaptive abilities of the bat, as explained in the film *Blind as a Bat*, which should be shown at this time.

Read to the class the article entitled "How Owls Hunt."

In a class discussion contrast the ways in which bats, owls, and other creatures use hearing to compensate for a lack of light and the inability to see as most animals do.

The very deep parts of the sea are dark. Ask the children whether there is life in such areas and, if so, how it gets along without light. (If there is a general "right now" kind of interest in this subject, the teacher or another pupil can read to the rest of the class. If individual learners are interested, they should be given time to read while their interest is keen.)

Describe a hypothetical situation wherein the members of the class, along with their families, must move to a planet that is totally dark. The people may take anything they need with them when they go; and they will be able to order supplies, at great expense, from the planet Earth. Have the pupils make plans regarding the equipment and supplies to be taken with them. Encourage the class to make one or several dioramas showing life-support systems, recreational facilities, economic provisions and developments, transportation systems, and the like—all of which are intended to make life livable and tolerable on the new planet.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Flashlights—one per three pupils
Hand magnifier—one per pupil
Motion picture projector

MATERIALS FOR ACTIVITIES

Cloth for blindfolding

Earthworms–one per pupil

Large cardboard cartons for dioramas

Milk cartons of several sizes

Plants–one per pupil (mint, geranium cuttings, and the like)

SELECTED REFERENCES

Books and articles:

Payne, Roger. "How Owls Hunt," *Nature and Science*, IV (January 30, 1967), 4–7.

Selsam, Millicent, and Betty Morrow. *See Through the Sea.* New York: Harper & Row, Publishers, Inc., 1955.

Simon, Seymour. *Animals in Field and Laboratory: Science Projects in Animal Behavior.* New York: McGraw-Hill Book Company, 1968. (See especially pp. 7–10.)

Thornton, Nancy M. "Lighting the Way for Plants," *Nature and Science*, VI (December 16, 1968), 6-7.

Film:

Blind as a Bat. The Moody Institute of Science, 1954.

Lesson Six: Food

As in the case of Lesson Five, this section on the eating habits of animals and certain food customs and contributions of people will have appeal for individual pupils. It will be appropriate for use also by a large group or by the class as a whole.

Behavioral Objectives

Affective:

The pupils will describe some of the difficulties that would likely be experienced by people or beasts in reestablishing a food supply after a natural disaster has occurred. (Analysis, valuation)

Cognitive:

The pupils will classify animals on the basis of the physical characteristics that determine what they eat. (Comprehension, response)

The pupil will explain the relationship between plant life and the survival of animal life. They will distinguish between herbivorous animals and carnivorous animals. (Synthesis, organization)

Teaching Strategies

The teacher uses the question technique in order to draw close attention to the relationships that exist among availability of food, ability to consume food, and survival.

The teacher uses a film to show in detail how the body parts of various animals are related to their eating habits.

The teacher uses an art project to illustrate the dependency of one life form upon another for survival.

The teacher uses class discussion to stress the concept of people's need for a balance of nature.

Suggested Activities

Ask the learners to name things that birds eat. From this list make a chart that shows the things eaten in each case, the kind of beak needed for the particular food or foods, and the kind of bird that is being considered. An example of such a chart follows:

Kind of food	*Kind of beak*	*Kind of bird*
Food from water	Broad, flat beak with sieve-like teeth	Duck
Rodents, small animals	Hooked beak for tearing flesh	Hawk, owl
Seeds	Short, stubby beak for seed pecking	Quail
Insects from tree bark	Chisel beak or wood-borer	Woodpecker
Nectar from flowers	Sucking beak	Hummingbird

Show the film *Animals—Ways They Eat.*

Display some illustrations of prehistoric animals.

Encourage the pupils to give logical reasons, on the basis of information they have gleaned from the film, to support their hypotheses about the eating habits of the illustrated prehistoric animals; that is, carnivorous or herbivorous eating habits.

Ask the children to name some carnivorous animals that are found in North America.

Pose the following questions: "Would these North American animals be able to find food if a drought caused plant life to die?" (Accept a "No" answer if the pupils do not perceive at this time the secondary consequences of such a drought.) "What animals might starve?" "Would carnivorous animals be affected if most of the herbivorous animals did starve?"

Ask also: "In what other ways is plant life used by carnivorous animals?" (Plants can be used for shelter, hiding places, perches, nests, and the like.) "How is the balance of nature (in this case, food supply) restored after a disaster, such as disease, flood, or fire?"

Begin another line of questioning: "If you were an aphid, what would you eat?" "If you were an aphid, what might eat you?" "If you were a (whatever ate the aphid), what might eat you?" (Continue in this manner to establish a "food chain.")

Provide each pupil with a long strip of adding machine tape. Let each child make an illustrated food chain by starting at the left of the tape with the name of a small life form and adding to the right of that entry the names of increasingly larger life forms that would consume the one designated at its immediate left.

Ask additional questions, such as those suggested in the paragraphs that follow:

"What do people do to avoid starvation between harvesting times?"

"Before refrigeration and canning were invented, which foods could have been stored for long periods of time?"

"Do people ever have too little food?"

"What do people do when a disaster causes a food shortage?"

"What ways have people found to preserve food so that it might be eaten at a later time?" (Methods include refrigerating, canning, dehydrating, freezing, smoking, pickling, pasteurizing, and vacuum packing.)

Resource Materials

EQUIPMENT FOR ACTIVITIES

Motion picture projector

MATERIALS FOR ACTIVITIES

Adding machine tape

SELECTED REFERENCES

Books:

"Abrams, Isabel S. "Sensitivity Sessions on Ecology," *Science and Children,* XII (April, 1975), 21–23.

Burt, Olive W. *The First Book of Salt.* New York: Franklin Watts, Inc., 1965.

Joy, Charles R. *Race Between Food and People.* New York: Coward-McCann, Inc., 1961.

Orr, John B. *The Wonderful World of Food.* Garden City, N. Y.: Doubleday & Company, Inc. (Garden City Books), 1958.

Ortleb, Edward P. "Ecology in the Elementary Classroom," *Science and Children,* IV (February, 1966), 29.

"Some Environmental Observations for Young Children," *Science and Children,* XII (April, 1975) 24-25.

Film:

Animals–Ways They Eat. Encyclopaedia Britannica Films, Inc., n.d.

Lesson Seven: Water

Like the two preceding lessons, this section on the important relationships between water and life is suitable for individual use. It is also suitable for use by small groups, by a large cluster group, or by an entire class.

Behavioral Objectives

Affective:

The pupils will express appreciation for the aesthetic qualities of water through art, music, or creative writing. (Valuation)

Cognitive:

The pupils will make a blueprint to record the root system of a plant. (Knowledge, response)

The pupils will compare root systems of fresh plants with those of dry plants. (Analysis, response)

The pupils will frame precise questions to gain understanding of an observed phenomenon. (Synthesis, organization)

Teaching Strategies

The teacher encourages the pupils to improve their skills of observation through recording the characteristics of a fresh plant and contrasting the characteristics with those of the same plant after it has dried.

The teacher uses a film to motivate the pupils to express their feelings through the arts.

Suggested Activities

Each member of the group or class should carefully soak the soil off the roots of a freshly dug dandelion or some other small plant.

Each participant should record the configuration of the plant by making a blueprint. (Instructions to the pupil: On an unexposed sheet of blueprint paper, hold the plant in place with a piece of glass. Place the assembled paper, plant, and glass in bright sunlight until the desired color contrast is obtained. Set the blueprint by placing it in a solution of 29.6 milliliters of hydrogen peroxide to 4.5 liters of water.)

Next, the pupils should list observable changes in their plants due to lack of water. The changes noted should be shared by all the pupils.

Some of the children may want to attempt to restore the plant to its earlier condition.

Cuttings of easy-to-root plants, such as geranium, mint, or pussy willow, should be started.

The learners should speculate about how growth may come from the stems even though the original roots cannot be restored.

Show the class a white carnation (a cut flower). Place it in a glass containing water that has been treated with food coloring. Set the glass in a warm, bright part of the classroom for a few hours. Make no explanations. The pupils will observe a change in the color of the carnation.

Allow the children to speculate about what has happened and to form their hypotheses into questions that can be answered by a "Yes" or a "No" from the teacher.

Encourage the pupils to participate in the activities described in the paragraphs that follow:

The class should read about the movement of water in plant stems and roots (Selsam, *Play with Plants*). Some of the experiments featured in Selsam's book should be tried.

Pupils showing exceptional interest may be attracted to a project designed to measure the pressure that forces liquid upward in plants (Klein and Klein, "The Sap Is Rising").

Freshly picked, individual leaves of various kinds should be tested for rates of transpiration by putting them in sealed plastic bags and placing the bags in warm sunlight.

The children should observe the leaves and classify them under certain categories, such as "needlelike," "waxy," and "broad."

The pupils should make generalizations about the relationship between physical characteristics of leaves and their rate of transpiration.

The learners should try to create experiments that will enable them to see how roots reach for water.

The teacher should read from the special-topic issue of *Nature and Science* entitled "Life in the Deserts."

The members of the class should plan a number of ways they might use to survive in a desert.

The pupils should dig a cone-shaped hole in an area where the sun will shine on the soil. A sheet of plastic should be placed over the hole in such a way that there are no openings. Moisture will begin to collect on the underside of the plastic. The class should discuss how and why this is happening, and a method should be chosen to collect the moisture so that it can be used. (If the plastic is allowed to sag slightly, droplets of water will gather at the low point and drop off.)

Conduct a class discussion about the fact that many people living in communities have expended tremendous effort to provide water for themselves.

Show the film *Rainshower*. In this unique film interpretive music and natural sounds take the place of narration.

Ask the children to express creatively their thoughts and feelings about the aesthetic qualities of water. The teacher might refer to these qualities as "the nice things we find" about water or "the things we enjoy" about water. The child should be allowed freedom of choice in the manner of expressing himself or herself. He or she may use prose or poetry, painting or sketching, music, drama, or whatever, as long as he or she feels that he or she is communicating his or her ideas. Some of the pupils may want to share their work with the class. Those who would rather not share it should not be forced to do so. It is important, moreover, that everyone in the class understand clearly that no grades will be given.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Motion picture projector

MATERIALS FOR ACTIVITIES

Blueprint paper
Food coloring
Hydrogen peroxide
Plastic sandwich bags
A plastic sheet, approximately 1.2 m x 1.2 m or larger
A white carnation (cut flower)

SELECTED REFERENCES

Books and articles:

Klein, Richard M., and Deana T. Klein. "How Roots Reach for Water," *Nature and Science*, V (January 8, 1968), 14-15.

Klein, Richard M., and Deana T. Klein. "The Sap Is Rising," *Nature and Science*, V (March 4, 1968), 2-3.

"Life in the Deserts" (special-topic issue), *Nature and Science*, V (October 30, 1967).

Selsam, Millicent E. *Play with Plants*. New York: William Morrow and Co., 1949. (See especially pp. 46–52.)

Film:

Rainshower. Produced by Dimension Films, 1965; distributed by Churchill Films.

Lesson Eight: Erosion

The relationships between erosion and the balance of nature are of great importance to a study of ecology. Since young children are naturally curious about the visible world around them, the many causes of erosion—wind, rain, fires, storms, water flow, land shifts, and the like, as well as the use and abuse of nature by people and the

need for control by people—will likely hold much attraction for the pupils as they learn the concepts of this lesson and apply some of these concepts in experiments and projects.

Although most of the material presented here is appropriate for use by individuals and by small groups, the class as a whole can become involved in the suggested learning experiences and can benefit greatly in so doing.

Behavioral Objectives

Affective:

The pupils will express feelings of social responsibility with respect to erosion caused by people. (Evaluation, characterization)

Cognitive:

The pupils will carry out experiments to determine the conditions controlling the amount and kinds of erosion that take place. (Analysis, response)

The pupils will discuss the effects of erosion in relation to a balanced ecology. (Synthesis, response)

Teaching Strategies

The teacher provides opportunities for the children to observe erosion taking place on a small scale by means of classroom experiments.

The teacher makes use of a film to illustrate erosion on a large scale.

The teacher utilizes group discussion to draw attention to the interrelationships between people and erosion.

Suggested Questions and Activities

Paint several large pieces of cardboard with calcimine solution, and let the pieces dry.

Ask the pupils how they themselves might be able to cause the paint to erode. Allow them to work in small groups for the purpose of trying to erode the calcimine.

As methods to erode the paint are devised, they should be recorded by the pupils on the chalkboard.

In a class discussion have the learners identify examples of erosion in nature that parallel the eroding processes used on the calcimine. For example, the children may have used some kind of abrasion that would have its parallel in nature with wind and water abrasion or with abrasion caused by people and animals on heavily traveled paths.

Make two garden-type nursery flats watertight by lining them with plastic. Fill one flat with rich loam and another with sandy soil. Scatter mustard seed rather thickly on each flat.

When the seeds have sprouted, cover one-half of each flat with plastic to protect it. With the flats slightly tipped, wind and rain can be simulated to demonstrate the differences in erosion on different kinds of soil.

Next, pull out a 2.5-centimeter-wide strip of mustard sprouts from side to side of one of the boxes. Place the box with the cleared strip in a horizontal position, and repeat the rain simulation procedure. The pupils will be able to see erosion in the cleared strip. Then tip the box with the strip to an uphill position, and water both boxes again. These actions will speed up the erosion considerably in the box with the cleared space.

Ask the children why the two flats were not affected by the wind and the water in the same way.

Give each pupil a teaspoonful of soil from both flats. A sharpened pencil can be used for a tool with which to separate the soil into small piles consisting of pieces of plant matter, sand, and the like.

Comparisons should then be made of the composition of the two kinds of soils; and conclusions should be drawn about the relationship between the composition of the soil and the rate of erosion.

Children who show particular interest in soil composition should be encouraged to compare more kinds of soil and also to "build" some soil. They can then test several kinds of soil for characteristics of water retention or compaction and explain their findings to the rest of the class.

Show the film *Erosion—Leveling the Land* to illustrate erosion and deposition of soil on a large scale.

Ask the following pertinent questions, and call for discussion:

"Does erosion change the lives of people?" The class should consider mud slides, earth slippage, sandstorms, silt in water, removal and relocation of topsoil, shifting beaches, and silt-filled harbors and marinas.

"Is all erosion caused by people?" The pupils should consider changes brought about during the Ice Age, fire caused by lightning, runoff after rain, earth movement along fault lines causing rechanneling and other changes in streams and rivers, alterations wrought by the wind, effects of exfoliation, slides caused by animal tunnels, and meadows created by beaver dams.

"Are the results of erosion always harmful?" The children should consider Yosemite Valley, San Francisco bay, mountain passes, and the use of rivers for transportation.

"Can people do anything about erosion?" The learners should consider contour farming; the provision of plant covering for bare ground; the reseeding of burned areas; the construction of mud control dams, drainage channels, and breakwaters; and other methods of prevention and control.

"Should people try to control all or nearly all erosion?" It is not necessary to elicit general agreement here. The prime concern of the teacher at this time is for each pupil to form an opinion and to have some reasons to support it. Opportunity should be provided for the children to reevaluate their thinking, and the question should be left open-ended.

Resource Materials

EQUIPMENT FOR ACTIVITIES

Motion picture projector

MATERIALS FOR ACTIVITIES

Calcimine paint
Cardboard—a supply of assorted large pieces
Garden-type nursery flats (two)
Mustard seeds
Plastic sheets—four pieces, each approximately 1 m x 1 m
Sprinkler bottles or cans

SELECTED REFERENCES

Books and other publications:

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Foster, Albert B., and Adrian C. Fox. *Teaching Soil and Water Conservation: Classroom and Field Guide* (Revised edition). Program Aid Series, PA-341. Prepared under the direction of the Soil Conservation Service. Washington, D.C.: U. S. Department of Agriculture, 1964.

Gaskell, Thomas F. *World Beneath the Oceans.* American Museum of Natural History. Garden City, N.Y.: Doubleday & Company, Inc., 1964. (See especially pp. 78-81.)

Vessel, Matthew F., and Herbert H. Wong. *Seashore Life of Our Pacific Coast.* Palo Alto, Calif.: Fearon Publishers, Inc., 1956. (See especially pp. 3–6.)

Film:

Erosion—Leveling the Land. Encyclopaedia Britannica Films, Inc., 1965.

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